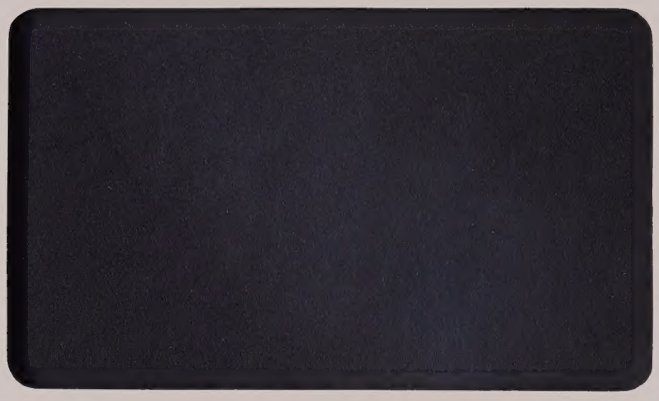
OPERATING AND INSTRUCTION MANAUL

MODEL PSC419 S-1176

PHASE SENSITIVE CONVERTER

NORTH ATLANTIC

industries, inc.



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MODEL PSC419 S-1176

PHASE SENSITIVE CONVERTER

NORTH ATLANTIC INDUSTRIES, INC.
Plainview New York

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CAUTION

High voltage exists at several points in the instrument. Normal precautions consistent with good practice should be taken to reduce shock hazard.

A potential shock hazard exists when ungrounded power source or ungrounded case operation is employed. Persons operating the instrument should be made aware of and take precautions against this condition.

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SECTION I

GENERAL DESCRIPTION

INTRODUCTION

The North Atlantic Phase Sensitive Converter performs a precise conversion of an AC input signal into a high level DC output linearly proportional to the average value of the full wave rectified input. When used in the Phase Sensitive Modes, the output is proportional to the average value multiplied by the cosine (In-Phase) or sine (Quadrature) of the angle between the signal and reference inputs. Orthogonality with respect to the frequency is maintained over a bandwidth of 5% through the use of matched, low phase gradient circuits. High degeneration in all circuits results in excellent linearity characteristics. Matched, high rejection filters eliminate errors due to harmonics in the signal and reference inputs. An output voltage of 0 to ± 10V DC will be obtained for any full scale AC input voltage within the available input ranges. Refer to Specifications, "Input Voltage Range".

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1.0 SPECIFICATIONS

1.1 Full Scale Input Voltage Range:

0.01V to 1000V in 5 separate programmable decade ranges.

1.2 Maximum Input Voltage:

300V RMS maximum A.C. on 1000V scale. Maximum D.C. plus peak 750V.

1.3 Full Scale Output Voltage: 0 to 1V D.C.

1.3.1 Output Impedance: 1.0 ohms

1.3.2 Maximum Output Current: 4ma

1.4 Function Modes: Total, Fundamental, In-Phase and Quadrature.

1.5 Output Polarity: The D.C. Output voltage shall be positive when the signal input voltage is in the first (signal input leading the reference input by 0° to 90°) or fourth (270° to 360°) quadrants. When the signal input is in the second (90° to 180°) or third (180° to 270°) quadrants, the output shall be of negative polarity.

1.6 Reference Input: 115V ± 10% at 400 Hz ± 5%.

1.7 Input Circuitry:

1.7.1 Direct: 1 megohm input impedance.

1.8 Reference Input: 100K at 400 Hz

1.9 Frequency Range:

1.9.1 Total: Direct - 350 Hz to 10 KHz.

1.9.2 Fund: 400 Hz ± 5%

1.9.3 In-Phase: 400 Hz ± 5%

1.9.4 Quad: 400 Hz ± 5%

1.10 Accuracy:

1.10.1 Total: 'Reference is 400 Hz. At this frequency output is within 0.1% of full scale.

Direct Mode: ± 1% 350 Hz to 10 KHz.

1.10.2 Fund:
1.10.3 In-Phase:
1.10.4 Quad:
} ± 0.1% of F.S. @ 400 Hz; plus an additional ± 0.5% of nominal ± .01V @ 380 Hz and 420 Hz.

1.10.5 Orthogonality: ± 0.05°

1.11 Frequency Response: The frequency response of the converter shall be as follows for a 400 Hz amplitude modulated input signal voltage where the carrier reverses phase at the π and 2π radian points (Nodes) of the modulated waveform.

1.11.1 Amplitude:

The output signal shall be flat within 0.1 DB for a 400 Hz signal modulated from 0 to 20 Hz.

1.11.2 Phase Shift:

The phase shift between the low frequency modulation waveform and the envelope of the demodulated output waveform shall vary linearly from 1° ± 1° at 1 Hz to 5° ± at 5 Hz.

1.12 Harmonic Suppression:

In the phase-sensitive modes, the minimum harmonic rejection ratio shall be as follows:

1.12.1 2nd harmonic - at least 40 DB

1.12.2 3rd harmonic - at least 45 DB

1.12.3 All higher order harmonics - at least 45 DB

1.13 Quadrature Rejection:

(In-Phase Mode) At 25°C the maximum null, when the signal input leads the reference input by 90°, shall be 0 ± 0.01 volts at 400 Hz plus an additional 2.0 mv gradient tolerance for each cycle of deviation from 380 Hz to 420 Hz. These values shall apply for any signal from zero to full scale.

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1.14 In-Phase Rejection (Quadrature Mode):

The maximum null when the signal input is in phase with the reference shall be 0 ± .01 volts at 400 Hz plus an additional 2.0 mv gradient tolerance for each cycle of deviation from 380 to 420 Hz. These values shall apply for any signal from zero to full scale.

1.15 Temperature Performance:

1.15.1 Amplitude:

1.15.1.1 At 71°C, the total tolerances of the output shall be the room temperature tolerances plus an additional ± 0.5% of the absolute value of the output signal and a linearity tolerance of ± 0.02 volts. The above applies following a 5 minute warmup.

1.15.1.2 At -40°C, the total tolerances of the output shall be the room temperature tolerances plus an additional ± 1.0% of the absolute value of the output signal and a linearity tolerance of ± 0.02 volts.

The aforementioned applies following a 5 minute warmup.

Rev. A 6/8/67
Rev. B 6/29/67

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1.15.2 Quadrature and In-Phase Rejection:

1.15.2.1 At +71°C the null tolerances shall be 0.050 volts plus an additional 2.5mv gradient tolerances for each cycle of deviation from 380 to 420Hz.

1.15.2.2 At -40° the null tolerance shall be 0.1 volts plus an additional 2.5mv gradient tolerances for each cycle of deviation from 380 to 420Hz.

1.16 Effect of Non Synchronous Power Frequency:

There is no degradation of performance or accuracy of the converter when the frequency of the power input voltage is not synchronized with the frequency of the signal and reference input voltages.

1.17 Overload Recovery:

After removal of 300V RMS signal from input, the output signal shall return to ± .02V of its final steady-state value within 1.5 seconds.

1.18 Over-Voltage Protection:

Voltages of up to 300V RMS can be applied directly to the input of the converter or any range without damage to the converter. Input impedance specifications are not applicable during over-voltage condition.

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1.19 Input Power:

115V ± 10% 50-400 Hz. Maximum current 0.25 amperes. Nominal resistance per relay is 1150 ohms ± 10% per coil (2 coils), 6 milliseconds (Minimum) pulse for programming.

1.20 Program Signal:

Programming can be actuated by positive or negative 28V ± 4V D.C. pulses for switching magnetic latching relays to program ranges, function modes, and input modes.

1.21 Fusing:

.5 amp fusing shall be externally supplied for power input.

1.22 Ground Circuits:

Internal signal ground shall be isolated from the case. For proper operation, internal signal ground must be connected to chassis ground externally.

1.23 Recovery Time From An In-Range Step Voltage:

The output voltage shall change to within ± 0.01 volts of the nominal value within 100 milliseconds.

1.24 D.C. Output Offset: At Zero input signal D.C. output is 10 mv maximum.

1.25 A.C. Output Noise:

At 10 mv input signal on 10 mv range, A.C. output shall be 50mv Peak to Peak.

2.0 DESIGN AND CONSTRUCTION

2.1 This unit shall be designed and constructed in accordance with MIL-T-21200, Class 3.

2.1.1 Temperature (Operating) -40°C to $+71^{\circ}$ C.

2.1.2 Temperature (Non-Operating) -62° C to 85°C.

2.2 See pages 9 and 10 for size and mounting dimensions.

3.0 FINISH

3.1 Lusterless black baked enamel per Fed. Std. 595 #37038 to all external surfaces.

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SECTION II

OPERATING INSTRUCTIONS

REMOVAL FROM PACKAGE

This instrument has been thoroughly tested, inspected, and evaluated at the factory prior to shipment. Particular care has been taken in the design of the special wrapping and packaging material used in the container to ensure that no damage result from the typical handling encountered during shipment. However, upon removal from package, the instrument should be externally inspected for any obvious damage. Should such be observed, refer to the Warranty Policy.

INITIAL CONNECTION

Apply power, 115V, 50-420Hz, to Pins A and B of connector J7. The components of the Converter will require a 15 minute warm up before stable operation conditions are reached.

> CAUTION: High voltage exists at several points in the instrument. Normal precautions consistant with good practice should be taken to reduce shock hazard.
>
> A potential shock hazard exists when ungrounded power source or ungrounded case operation is employed. Persons operating the instrument should be made aware of and take precautions against this condition.
>
> North Atlantic Industries, Inc. cannot be held responsible for damage to person or property in the process of or as a result of maintenance, calibration, or setting up of instrument.

Apply input signal to Pins A and B of connector J6 with Pin B used as the low side. The AC reference input is applied to Pins E and F of connector J 6 with Pin F used as the low side. Since this instrument does not contain an internal reference isolation transformer, an external reference isolation transformer must be provided.

> NOTE: The voltage at Pin E is in-phase with the voltage at Pin A.

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A positive DC output will appear across pins C (high) and D (low) of connector J6 for Total, Fundamental, and In-Phase inputs. An input signal which is at an angle of 90° or 270° with respect to reference in the In-Phase Mode will produce 0 volts output.

GROUNDING

In order to prevent ground loops, the chassis of this instrument has been isolated from the instrument circuit ground. It is necessary for proper operation that the instrument circuit and chassis ground be at the same potential and hence connected together. This connection may be made either external or internal to the instrument but must be done at only one point.

It is recommended that the low side of the signal (Pin B of J6) be connected to the chassis ground (Pin C of J7). In many systems, the case of the instrument is physically connected to a console whose frame is connected to a main ground. In this case, it is best to connect the circuit grounds to this main ground and eliminate the use of Pin C of J7. This would result in connection of chassis ground to circuit ground at two points resulting in a ground loop.

In addition, the low side of the power source should be tied to Pin B of J7. This will reduce the effect of stray power ground currents.

PROGRAMMING

Function and Range - The desired operating conditions may be selected by applying a ±28V DC (±4V) to the appropriate pins of connector J8 (see programming section).

Function Selection - The Function Program is used to select the desired mode of operation. One of four available modes may be selected:

Total Mode - The DC output signal is proportional to the entire AC input signal. (RMS).

Fundamental Mode - The DC output signal is proportional to the RMS magnitude of the fundamental component of the input signal.

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In-Phase Mode - The DC output signal is proportional to that component of the input signal which is In-Phase with the reference signal.

Quadrature Mode - The DC output signal is proportional to that component of the input signal which is at a phase angle of 90° with respect to the reference signal.

Range Selection - The Range Program is used to select one of six (.01V, .1V, 1V, 10V, 100V, 1000V) available input ranges. (Note 300V maximum on 1,000V range).

OPERATION

This instrument will operate within the specified accuracy into any load in excess of 2500Ω.

Phase Trim - Because of source impedance effects, differences of frequency, etc., some small phase errors may be present between the Signal and Reference Channels. In order to trim these errors, the following procedure should be used.

Program range to the most sensitive range and function to the Quadrature Mode. Apply an in-phase signal equal to the most sensitive full scale value to the input terminals. The output should be 0 ± 10mv. If not, the output may be zeroed by adjusting R1116 which is found beneath the Phase Trim button on the top of the instrument.

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CONNECTOR INFORMATION FOR PSC 419-S1176

8 Pin Connector J6

A - HI Sig. Input
B - LO Sig. Input
C - HI DC Output
D - LO DC Output
E - HI Ref. Inout
F - LO Ref. Input

3 Pin Connector J7

A - HI 115V
B - LO 115V
C - Chass. Grd.

19 Pin Connector J8 (Programming)

To program to the desired range or function, apply 28V DC to the appropriate pins as indicated. (Note that either polarity may be used.)

Range	+28V Program Energize	-28 Program Energize
.01 V	DKV	ELR
.1 V	DLR	EKV
1 V	DKR	ELV
10 V	EKV	DLR
100 V	ELR	DKV
1000 V	EKR	DLV

Function		
Total	BP	AC
Fundamental	AP	BC
In Phase	AMC	BNP
Quadrature	ANC	BMP

Pin F is the return line for all relays.

SECTION III

THEORY OF OPERATION

GENERAL

The block diagram and schematic of Figures 3.1 and 3.2 serve to illustrate the principles of operation of the Phase Sensitive Converter.

The Phase Sensitive Converter, as stated previously, has the capability of providing DC outputs proportional to the AC inputs in four different function modes, as desired. The Phase Sensitive Converter has two independent channels. The Total and Fundamental Modes of operation make use of the Signal Channel only, much in the same manner as a conventional voltmeter. The difference between the two modes is the insertion of a harmonic filter in the Fundamental Mode to limit the frequency response to the design frequency. The Reference Channel is disabled during these modes of operation. For phase sensitive operation (In-Phase and Quadrature Modes), the Reference Channel is activated. The reference signal is amplified and phase shifted by the reference circuitry. This signal serves to gate the demodulator. The phase relationship of this gating voltage to the signal being measured will determine the magnitude and the polarity of the DC output voltage. The output voltage will change as a cosine function of the phase angle from 0° through 360°.

The following paragraphs are a detailed description of the above-mentioned channels and their various components.

PLUG-IN MODULES

The amplifiers used in the Phase Sensitive Converter are of silicon solid-state design. These are contained within the plug-in modules along with relays and other circuit components. All designs are based on the use of components well below maximum manufacturers' ratings to insure long life and trouble-free operation. These modules are factory sealed and in the event of failure should be replaced as a unit. The individual modules are described as follows:

Range Attenuator Assembly #782411

The Signal Channel of the PSC-419 always operates with a basic full scale sensitivity of 10mv. This requires attenuators for reducing higher level voltages to this range. The input attenuator actually consists of 3 separate voltage divider networks. They provide attenuations of 1000:1, 100:1 and 10:1. The six full scale ranges are selected by programming each of the attenuators individually or in combination. When properly adjusted, they provide the necessary attenuation over the frequency band required for Total Mode operation and essentially zero phase shift for Phase Sensitive operation.

The 1000:1 attenuator is isolated from the other two attenuators by a unity gain, high impedance input, isolation amplifier which is included inside the module.

Signal Input Assembly, #782406

This assembly contains the Signal Pre-Amplifier which provides a stable gain of 70 which is necessary for the 10mv sensitivity of the instrument. Large amounts of negative feedback are used so that its gain is controlled soley by stable precision resistors. Its design is such that it provides a wide band frequency response with minimal phase shift and low noise. Also contained within this module are the source and load resistors for the signal filter L1, a resistive network which simulates the attenuation of the filter when the instrument is programmed into the Total Mode, and K1502 which switches between the two circuits.

Signal Output Assembly, #782410

The Signal Output Assembly contains a unity gain, isolation amplifier and a signal amplifier. It is the function of the isolation amplifier to present a high impedance load to the signal input amplifier and to present a low impedance source to the output signal amplifier.

The output signal amplifier has a very high gain bandwidth product resulting in a phase shiftless power gain. The power gain is required to drive the demodulator circuit which is contained in the Gated Signal Converter.

Reference Input Assembly, #782404

This assembly contains the phase shift network, the phase trim network, and a square wave generator circuit as well as two isolation amplifiers. It is the function of the phase shift network to provide an accurate 90° phase shifted reference signal in the Quadrature Mode. The 0° network provides a like amplitude signal at an angle of 0° in the In-Phase Mode. Because of the phase shift network's sensitivity to resistive and capacitive loads, an isolation amplifier is inserted at this point. This isolation amplifier not only provides the high impedance, low capacity load to the phase shift network but provides a low impedance source to the phase trim network.

The phase trim network provides the capability of aligning the overall phase shift in the Reference Channel to coincide with with Signal Channel. This circuit also being sensitive to loads requires that it be isolated from the succeeding circuitry. The second isolation amplifier is included for this purpose. At this point in the Reference Channel, the reference filter L2, which is located outside of the module, is connected. The filtered reference signal is now fed into the Square Wave Generator. It is the purpose of the Square Wave Generator to amplifier and clip the reference signal so the zero crossing of the reference signal is accurately preserved.

Also contained within the module are relays K1101 and K1102. It is the function of K1101 to select the 0° or 90° output from the phase shift network. K1102 disables the Reference Channel in the Total and Fundamental Modes by shorting the output of this module to ground.

Gated Signal Converter, #782405

This module contains the circuitry which performs the ultimate operation of converting the AC input signal to a DC output. In the Total and Fund Modes, the demodulator is self-gated by the AC voltage from the Signal Output Amplifier. The pulsating DC output of the demodulator is differentially summed in the DC differential amplifier. The unipolar output of the differential amplifier is then fed out of the module to the output filter L3 where the AC component is filtered out. This filtered signal is then fed back into the module to a DC amplifier which provides the extremely low output impedance and power gain to the output terminals of the converter.

In the Phase Sensitive Modes, the square wave output of the reference input module is amplified by the square wave amplifier and coupled to the Phase Sensitive Demodulator. It is the purpose of the reference signal to synchronously gate the Phase Sensitive Demodulator so as to accurately convert the AC signal to a DC signal as a function of phase shift.

The Phase Sensitive Demodulator operation can be likened to that of a set of commutating switches which alternately connect the output of the Signal Channel to the differential amplifier. A portion of this demodulated signal which appears across R1390 is fed back to the signal output module. This feedback is used to eliminate the effects of component non-linearities.

In the Phase Sensitive Modes when the reference and signal voltages are in-phase, the DC output signal will be maximum. When these voltages are 90° apart, the result will be a null and the DC output will be zero.

Power Supply #782408

The power supply of the PSC-419 is designed to provide several different DC voltages. Each of these DC voltages is well filtered and with the exception of the +60V is zener regulated.

Filters

Signal and reference filters, L1 and L2, NAI #202626 are low pass filters designed to cut off frequencies above the operating frequency. Their use in the Signal and Reference Channels provides sufficient rejection of harmonics and noise consistent with the overall instrument specifications. In addition, these filters contain compensation for amplitude variation with temperature.

Output Filter L3, is an exceedingly flat, low pass filter with a cut off at the frequency of operation. This filter is designed to result in an optimum between maximum filtering of ripple and minimum settling time.

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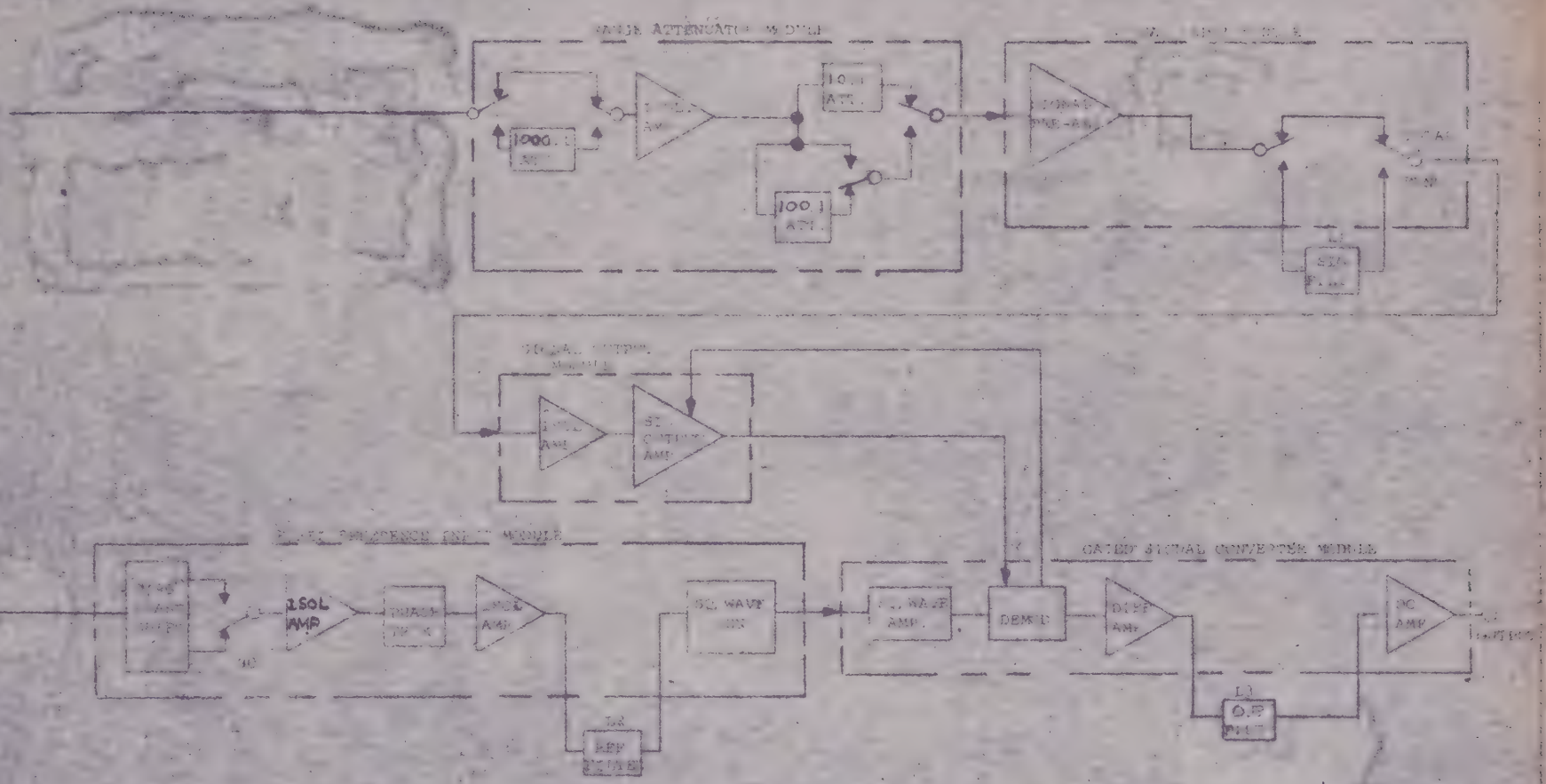
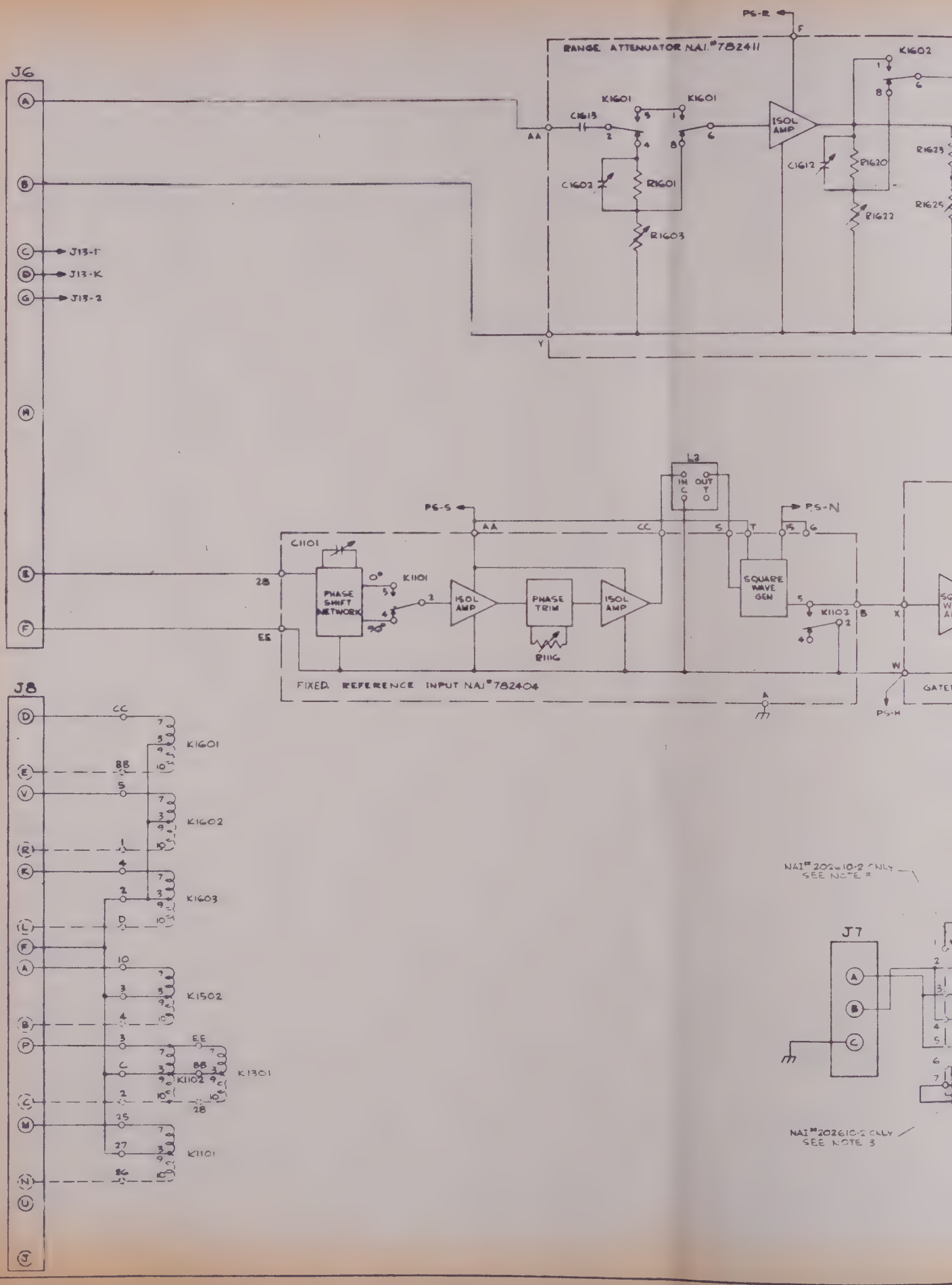
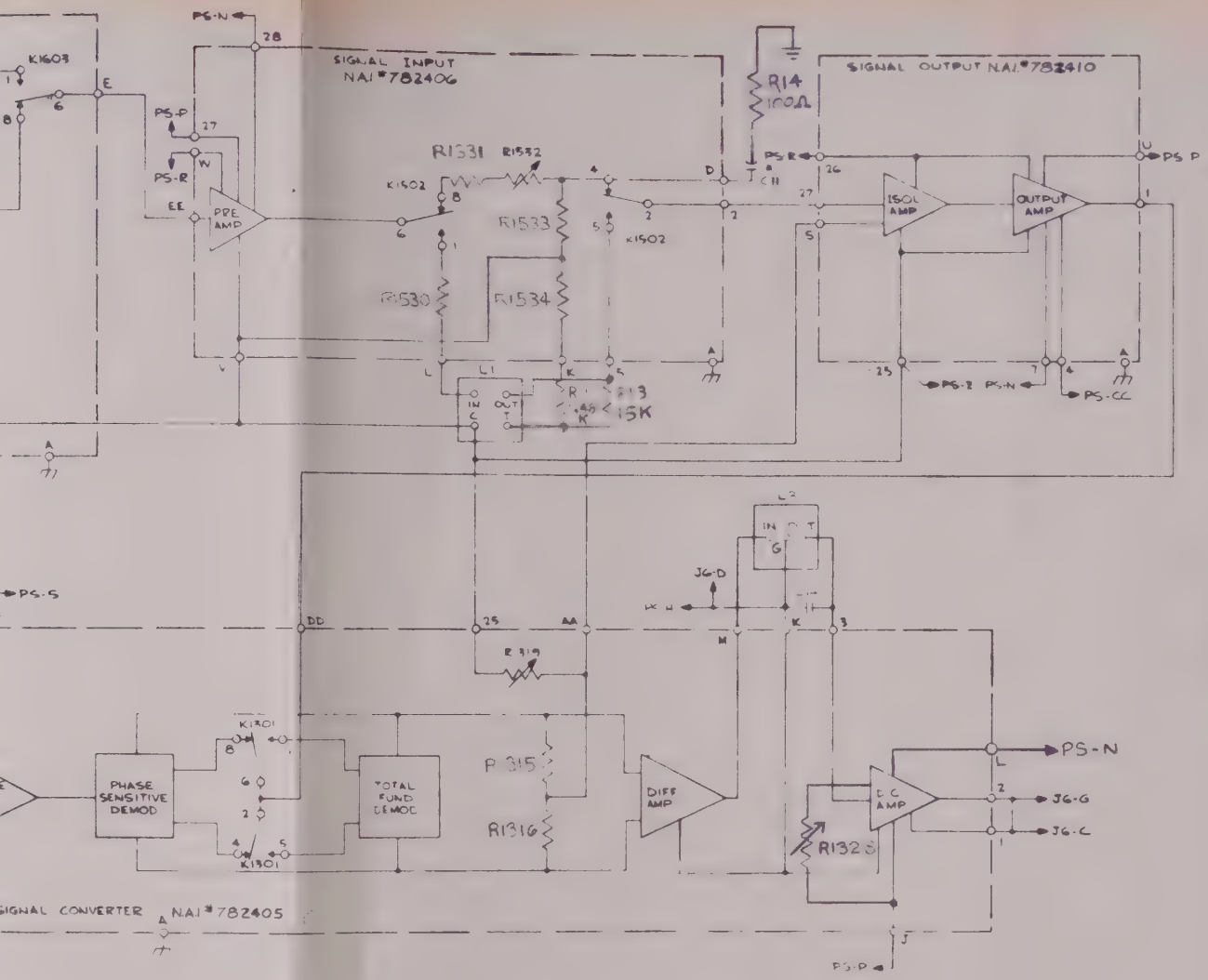
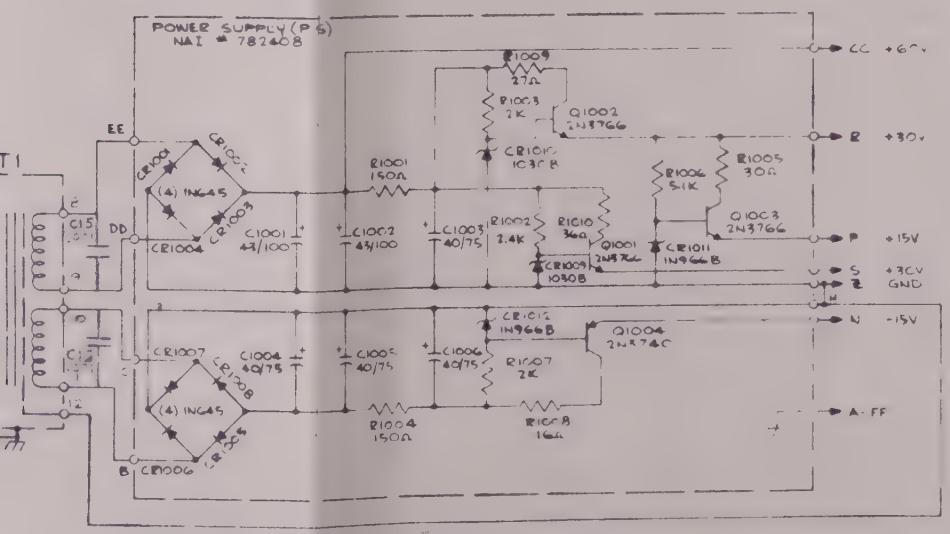


BLOCK DIAGRAM
Figure 3.1

PSC 419-S1176


J6
PS-R
RANGE ATTENUATOR NAI*782411
K1601
K1601
C1613
ISOL AMP
K1602
C1612
R1620
R1623
C1602
R1601
R1622
R1625
R1603
J13-1
J13-K
J13-2
L2
PS-S
PS-N
C1101
PHASE SHIFT NETWORK
K1101
ISOL AMP
PHASE TRIM
ISOL AMP
SQUARE WAVE GEN
K1102
R1116
FIXED REFERENCE INPUT NAI*782404
PS-M
J8
K1601
K1602
K1603
K1502
K1301
K1102
K1101
NAI*202610-2 ONLY
SEE NOTE 2
J7
NAI*202610-2 ONLY
SEE NOTE 3





NOTES.
1. ALL CAPACITORS ARE IN μfd UNLESS OTHERWISE SPECIFIED.
2. # SELECT IN TEST.
3. NAI* 202610-1 IS SUPPLIED AS A STANDARD TRANSFORMER AND DOES NOT INCLUDE WINDINGS 15 & 16. NAI* 202610-2 IS SUPPLIED ON SPECIAL ORDER

* LATCHING RELAY CONNECTIONS ARE SHOWN AS DOTTED LINES
- ALL RELAYS ARE SHOWN IN DE-ENERGIZED POSITION

SCHEMATIC PSC419(S-1?) REV. A

Errors Caused by Harmonics in Various Types of Detectors

The manner in which harmonic distrotion affects AC to DC conversion accuracy of a pure sinusoidal fundamental signal depends on the detector used. There are three general methods of performing AC to DC detection.

1. Averaging detector
2. "True RMS" converter
3. Peak detector

The first (averaging) is used commonly in vacuum tube voltmeter circuitry. A typical averaging detector circuit can result in the range of errors listed in Table I as a result of second and third harmonic content in theAC signal being measured.

Converting AC to DC in a true RMS manner reduces errors due to harmonics in those cases where the harmonic amplitude is low compared to fundamental, but not where the harmonic amplitude is high (compared to the fundamental) as shown in Table 2.

A peak detector would result in errors which may be as great as the percentage of harmonic content in the signal being measured. This applies for all orders of harmonics and depends mainly on the phase relationship between the fundamental and each of the harmonics.

The above three basic techniques all convert an AC waveform to a DC value by straightforward rectification of conversion, independent of the phase of the measured signal.

In the phase sensitive detector, even order harmonics have no effect on the results. Error due to odd order harmonics is the percent distortion divided by the order of the harmonic. For example, 9% third harmonics would result in an error of 9 divided by 3, or 3%. Table 3 shows the errors that may be expected from the phase sensitive detector for the same conditions listed in Tables 1 and 2.

Table 1 - Errors Due to Harmonics in a Typical Average Detector

Harmonic Order	Harmonic Content	Error
2nd	10%	Nil
2nd	20%	0 to +2%
2nd	50%	0 to +10%
3rd	10%	-4% to +4%
3rd	20%	-8% to +8%
3rd	50%	-10% to +16%

Table 2 - Theoretical Errors Due to Harmonics in True RMS Detector

Harmonic Order	Harmonic Content	Error
2nd	10%	+0.5%
2nd	20%	+2%
2nd	50%	+12%
3rd	10%	+0.5%
3rd	20%	+2%
3rd	50%	+12%

Table 3 - Theoretical Phase-Sensitive Average-Detector Errors Due to Harmonics

Harmonic Order	Harmonic Content	Theoretical Error (No Filters)
2nd	10%	None
2nd	20%	None
2nd	50%	None
3rd	10%	-3.3% to +3.3%
3rd	20%	-6.7% to +6.7%
3rd	50%	-16.7% to +16.7%

In order to determine the effects of harmonics on the ring bridge demodulator circuit, consider the introduction of second harmonic which is in the same phase as the reference (Figure 3.3). The current through the meter has an average value equal to 0. Figure 3.4 shows that a second harmonic signal which is out of harmonic phase also has no effect. Once again, the average value is zero. Thus, a phase sensitive detector similar to a ring bridge is unaffected by second harmonic distortion regardless of the phase of the harmonic. The same analysis can be carried forth for all even order harmonics.

Let us now consider the introduction of third harmonic. Where the third harmonic is in harmonic phase with the reference (Figure 3.5), there are four positive half cycles flowing through the meter and two negative half cycles. Therefore, the current flowing through the meter circuit is 1/3 the value of the same amplitude of fundamental frequency applied as a signal. A third harmonic out of harmonic phase would result in the waveform shown in Figure 3.6. The resultant D. C. current is again 0. Therefore, the effects of odd-order harmonic on a phase sensitive detector can be anything from zero (where the harmonic is out of harmonic phase) up to a reading equal to the ratio of the harmonic amplitude to the fundamental reduced by a factor of the order of the harmonic (where the harmonic is in harmonic phase with the fundamental).

A general expression of the signal produced by any odd harmonic is thus:

$$I_m = K \frac{E_h}{nE_t} \cos \theta_h$$

Where I_m = D. C. output current; K = Proportiónality constant; E_h = RMS value of harmonic; E_t = RMS value of fundamental; n = order of harmonic; θ_h = harmonic phase (defined in degrees of harmonic as related to the zero crossing of the fundamental). This potential "harmonic error" is eliminated by the filters in both reference and signal channels of the phase sensitive converter.

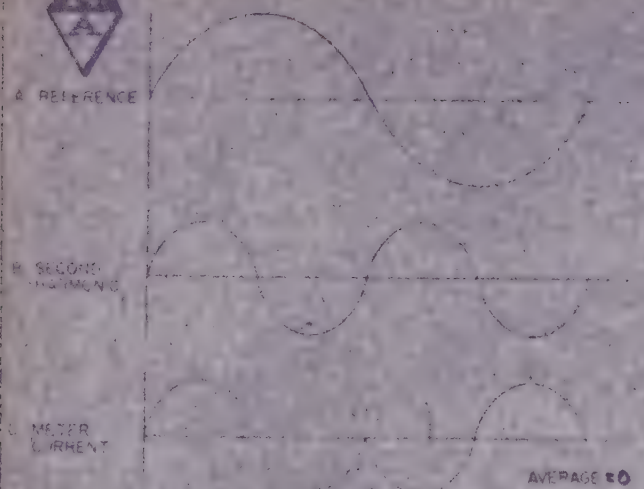


FIG. 3.3 SECOND HARMONIC in phase with reference has no effect on reference controlled bridge demodulator.

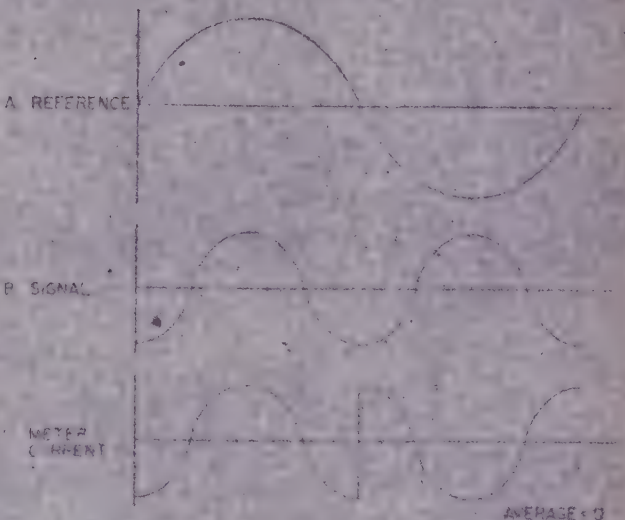


FIG. 3.4 SECOND HARMONIC has no effect when out of phase with reference.

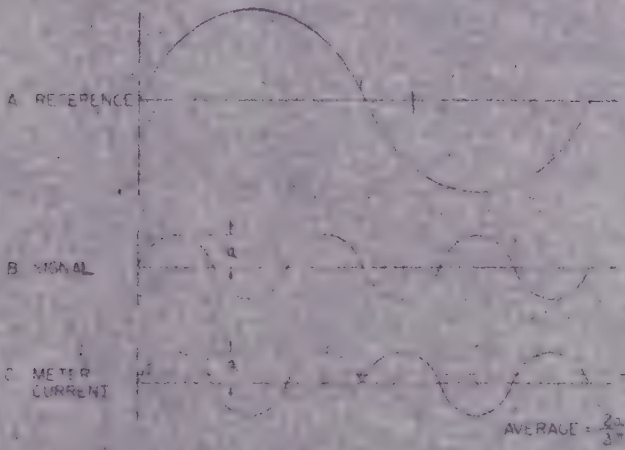


FIG. 3.5 THIRD HARMONIC (in phase) does not affect the output.

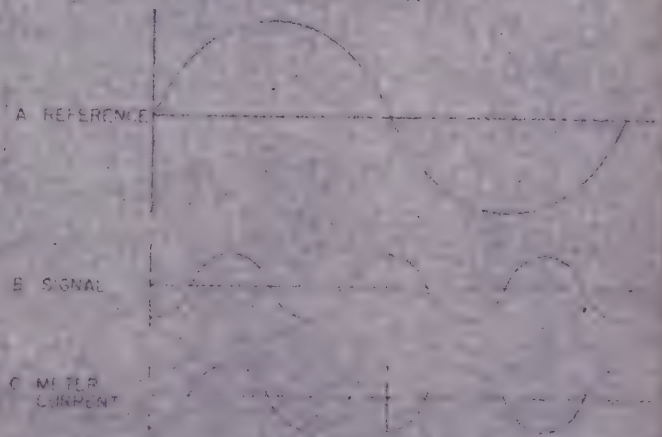


FIG. 3.6 THIRD HARMONIC (out of phase) does not affect the output.

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200 terminal drive, plainview, n. y.

SECTION IV

MAINTENANCE

The following section contains instructions for the maintenance of the Phase Sensitive Converter.

COVER REMOVAL

To remove cover, remove 10 screws from the sides and top of the U-shaped cover. In the event that the instrument must be trouble shot, it will be necessary to remove the bottom cover which is held in place by 6 screws.

AMPLIFIER AND COMPONENT REPLACEMENT

Remove two screws on either side of the amplifier to be removed. The amplifier may then be unplugged from its socket and replaced. Upon replacement, part numbers must be checked to guarantee proper location and hold down screws must be replaced at either end of the module.

RELAYS

All relays are plug-in relays. To replace these relays, it is first necessary to remove the module from its socket. The two screws must then be removed from the relay hold-down bracket. The relay may then be removed and replaced. Upon replacing the relay bracket, the case of the relay should be checked to see that it is connected to case ground of the modules (Pin A of the module connector).

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REPLACEMENT PARTS LIST

DESIGNATION	DESCRIPTION	NAI PART NO.	MANUFACTURER
C11	Capacitor, Fixed, Select at Test		
C15,C16	Capacitor, Fixed, Mica, 1000uuf, ±10%, 100V	801240	
C1101	Capacitor, Variable, Ceramic, 8-25uuf, 300V	802694	
C1602	Capacitor, Variable, Ceramic, 3-8uuf, 500V	804261	
C1612	Capacitor, Variable, Ceramic, 2-8uuf, 300V	803417	
R11	Resistor, Fixed, WW, 1.481K, ±.25%	*203034-3	
R12	Resistor, Fixed, WW, 3K, ±.25%	*203034-3	
R13	Resistor, Fixed, C.D., 15K, ±1%, 1/2W	800066	
R14	Resistor, Fixed, Comp., 100Ω, ±10%, 1/4W	801412	
R1319	Resistor, Variable, Cermet, 5K	803914	
R1328	Resistor, Variable, WW, 20K	803647	
R1603	Resistor, Variable, WW, 20Ω	803730	
R1622, R1625	Resistor, Variable, WW, 100Ω	803416	
R1001,R1004	Resistor, Fixed, WW, 150Ω, ±1% 5W	803732	

*Supplied as a matched set.

Consistent with North Atlantic Industries' policy of continuously up-grading components and improving circuits, we reserve the right to substitute components which are functionally interchangeable for any of the parts shown above.

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REPLACEMENT PARTS LIST

DESIGNATION	DESCRIPTION	NAI PART NO.	MANUFACTURER
K1101,K1102, K1301,K1501, K1502,K1601, K1602,K1603	Relay, 28V DC, Latching	201879	
Q1001,Q1002, Q1003	Transistor, 2N3766	803690	
Q1004	Transistor, 2N3740	803691	
	Assembly, Power Supply	782408	
	Assembly, Range Attenuator	782411	
	Assembly, Signal Input	782406	
	Assembly, Signal Output	782410	
	Assembly, Gated Signal Converter	782405	
	Assembly, Fixed Reference Input	782404	
T1	Transformer, Power	202610-1	
L1,L2	Filter, Signal and Reference (supplied as matched pair)	202626-1	
L3	Filter	801030	
J6	Connector, 8Pin	801208	
J7	Connector, 3Pin	801209	
J8	Connector, 19Pin	801210	
J10,J11,J13, J16	Connector, P.C., 56 Contact	802947	

Consistent with North Atlantic Industries' policy of continuously up-grading components and improving circuits, we reserve the right to substitute components which are functionally interchangeable for any of the parts shown above.

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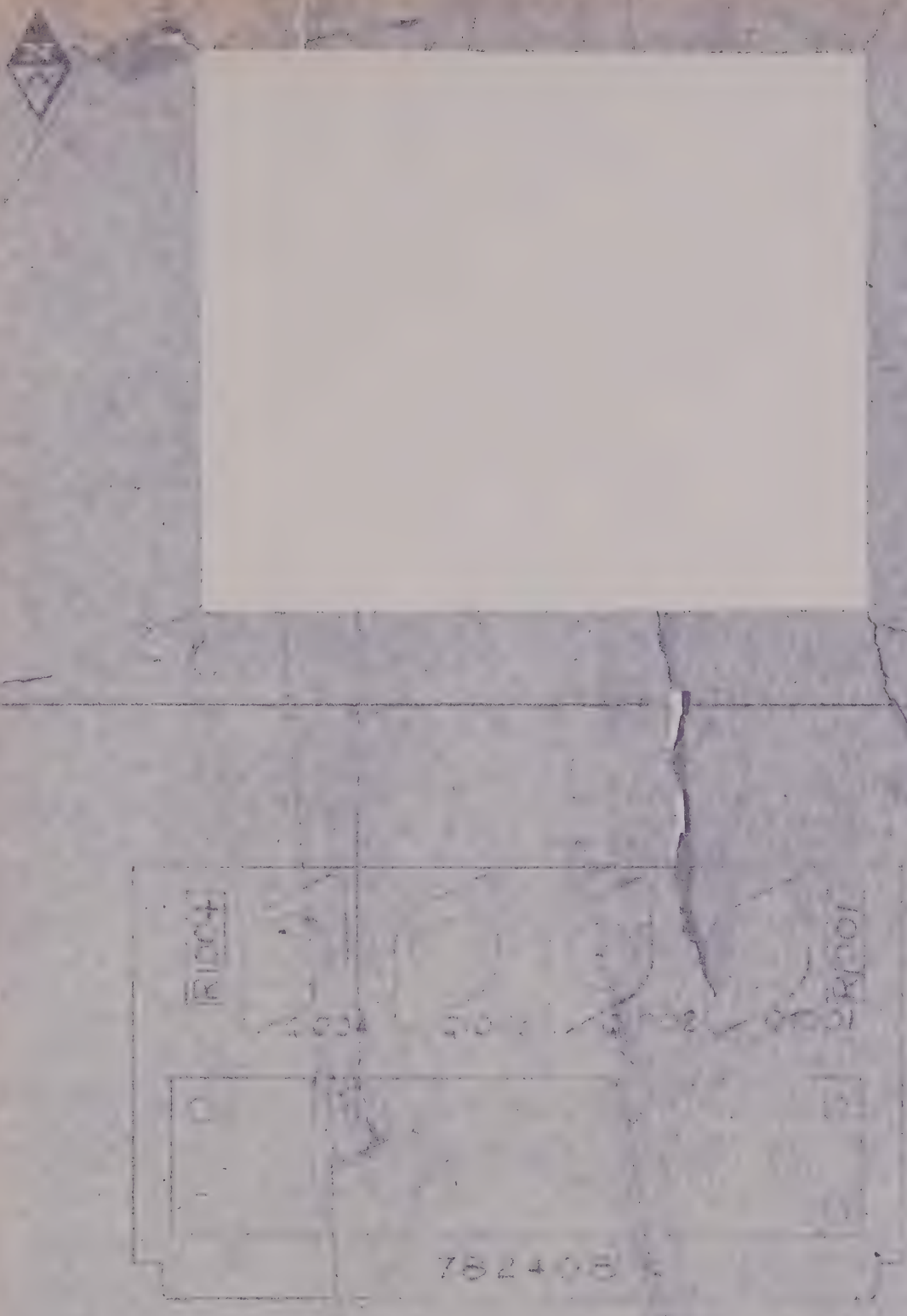

4.4

NORTH ATLANTIC

RELAY LOCATIONS

PSC-419 S1176

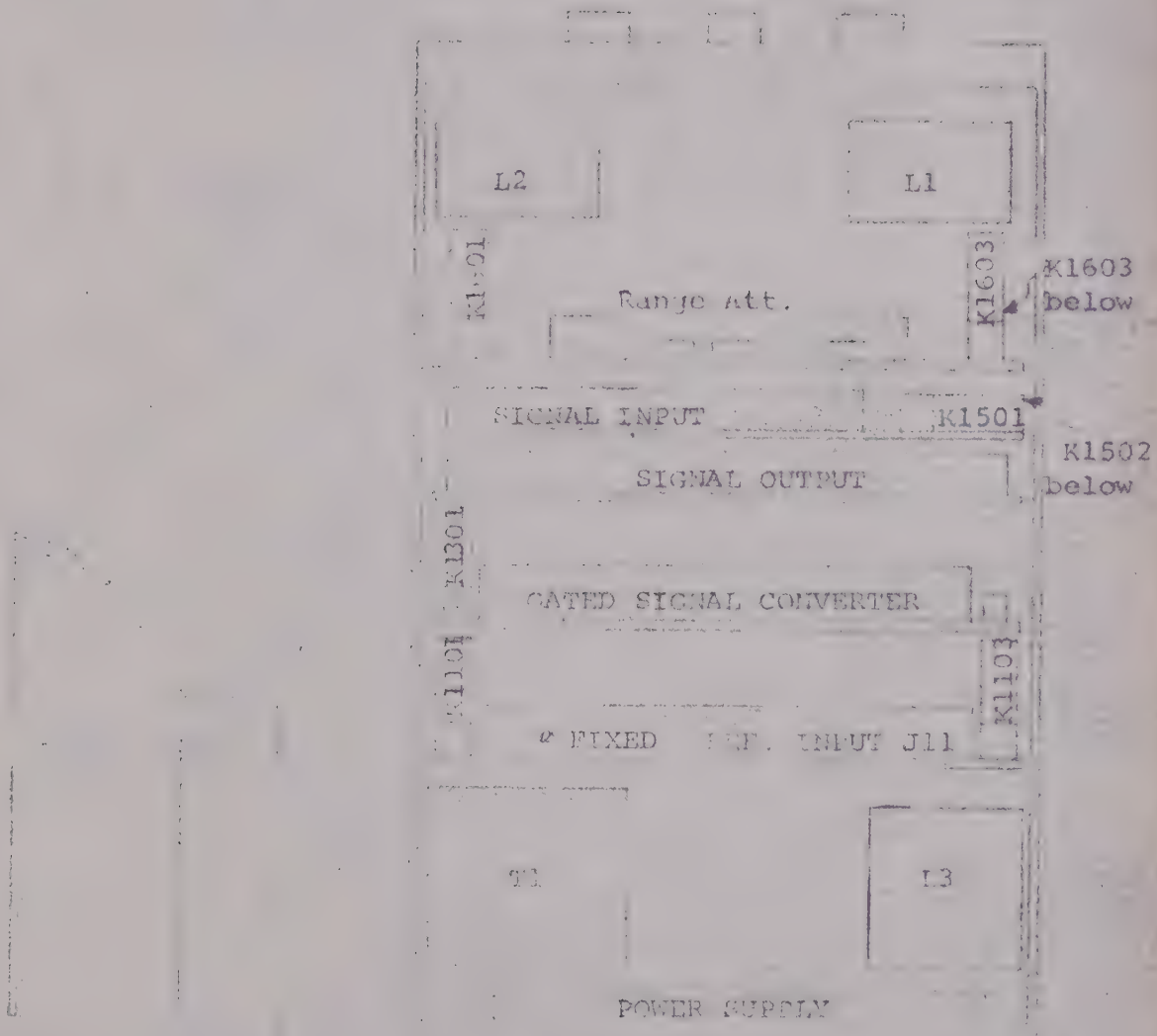

FIGURE 4.2

CALIBRATION ADJUSTMENT LOCATIONS

PSC-419-S1176

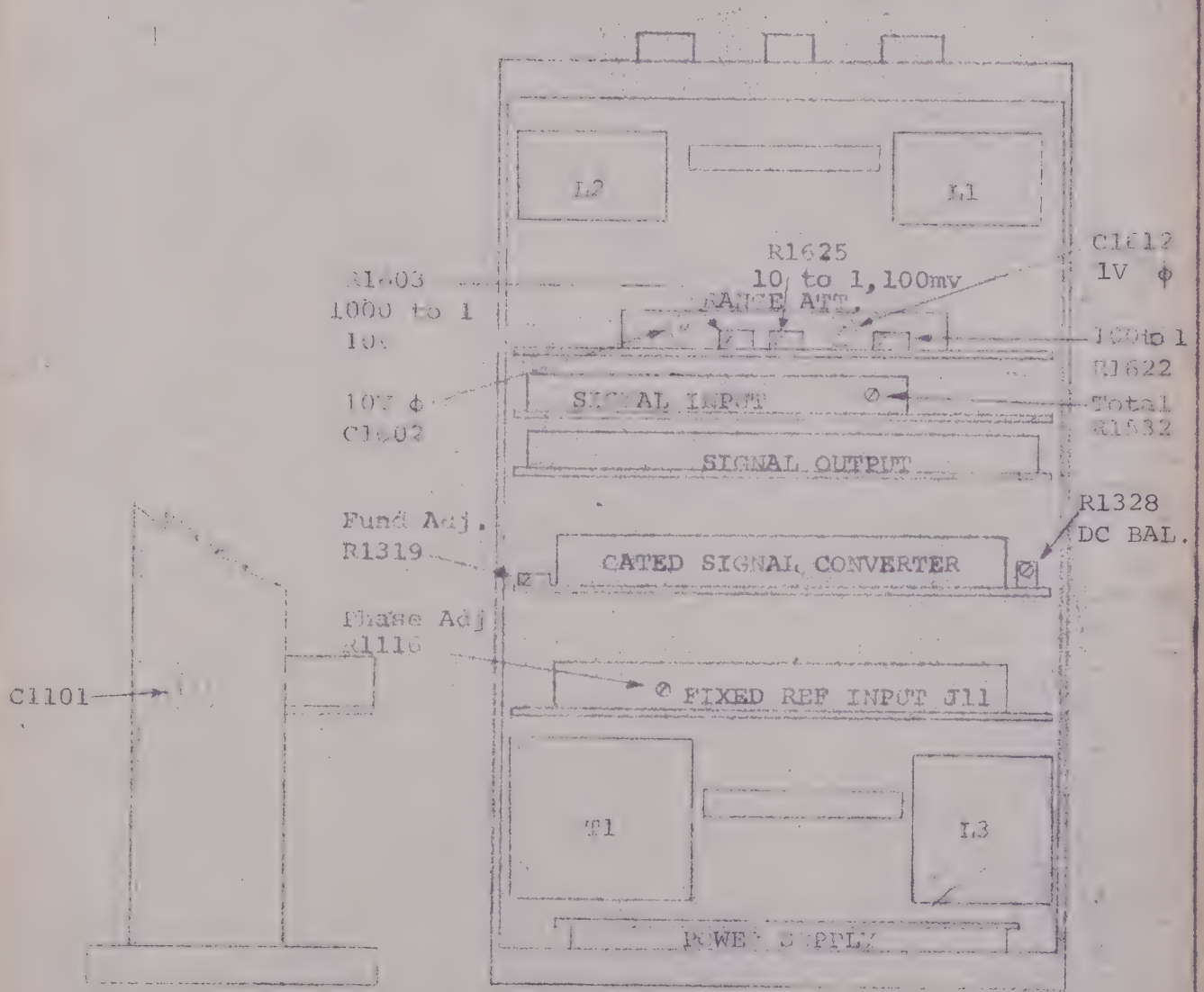

Figure 4.3

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TROUBLE SHOOTING PROCEDURE

A. Malfunction of the PSC-419-S-1176 would first be evidenced by improper output readings in the system. The primary power input, signal and reference inputs, and programming voltage should be verified prior to proceeding to trouble shoot the Phase Sensitive Converter since erroneous readings may be the result of a malfunction in the associated system equipment.

B. Having determined the erroneous readings are,due to the Phase Sensitive Converter, the first trouble-shooting technique should be to replace any plug-in module, which may be suspected as the cause of the trouble (refer to the Theory of Operation, Section III). If the replacement of plug-in modules does not remove the trouble, it will then be necessary to investigate the individual components of the Phase Sensitive Converter.

C. There are certain components that, if defective, will render the instrument inoperative in all Ranges and Function Modes. The condition of these components should be checked if the unit is completely inoperative. These components are the Output Filter L3 and the Power Transformer T1.

D. The trouble shooting chart will aid in isolating a malfunction in the instrument. An AC signal source and a 28V DC source will be required (see Section V for equipment required).

NORTH ATLANTIC

TROUBLE SHOOTING CHART

TROUBLE	PROBABLE CAUSE	REMEDY
No reading or improper reading on Direct Mode input for all ranges and modes.	Range Attenuator Ass'y Signal Input Ass'y Signal Output Ass'y Gated Signal Conv.	Check each module by plugging in a replacement.
	Filter L3, Relays K1501,K1502,K1301, C14	Check and replace defective components
Direct Mode: Improper reading on 0-100mv range only.	Relays K1602,K1603	Checking winding, pins 3-7. Check between contacts. If defective, replace relay.
	Range Attenuator Ass'y	Check by plugging in replacement module.
Improper reading on 0-1V range only	Relays K1602,K1603	Check relays as above. Replace if defective.
	Range Attenuator Ass'y	Check by plugging in replacement module.
Improper reading on 0-10V range only	Relays K1601,K1602 K1603	Check relays as above.
	Range Attenuator Ass'y	Check by plugging in replacement module.

TROUBLE	PROBABLE CAUSE	REMEDY
Improper reading on 0-100V range only	Relays K1601,K1602, K1603	Check relays as above. Replace if defective.
Improper reading on 0-1000V range only	Relays K1601,K1602, K1603	Check relays as above. Replace if defective.
Direct Input, Total Mode: Improper output, only in this mode.	Signal Input Ass'y	Check and replace defective components.
	Relay K1502	Check relay as above. Replace if defective.
Direct Input, Fund Mode: Improper output, only in this mode.	Relay K1502	Check relay as above.
	Filter L1	Check Filter L1 and replace if defective.

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The PSC-419 contains a number of plug-in, sealed components and assemblies. If a malfunction is isolated to a plug-in relay, or one of the sealed transistorized modules or components, the relay module or component must be replaced. No repair of the components is possible. The exposed circuit components on the assemblies and chassis can be replaced. Care must be taken to replace any of these components with those specified in the replacement parts list.

SECTION V

TEST AND CALIBRATION PROCEDURE

PERFORMANCE EVALUATION TEST PROCEDURE

I. Introduction

The data recorded as a result of following this procedure may be used for evaluation test on new units or as a routine calibration record, as required, by all customers. It should also be followed if maintenance requires that components be replaced. In the latter case, the results obtained will determine the extent to which an instrument must be recalibrated and realigned.

II. Equipment Required

a. Test Panel, North Atlantic #782266.
b. Precision DC Readout (Fluke Model 883A or equal)
C. Precision AC Source:
   Oscillator (Krohn-hite Model 446R, or equal)
   Amplifier (Krohn-hite Model DCA-10R, or equal).
d. 28V DC ± 4V Power Supply (DB Model 21101B or equal).
e. AC Monitor (Krohn-hite Model AC-601R or equal).
f. Ratio Box, North Atlantic RB-503C or equal - 3 required.
g. Ratio Box, North Atlantic RB-504 or equal - 1 required.
h. Step-up Transformer 115:300, North Atlantic #782257 or equal.
i. DC - VTVM (Hewlett-Packard 412A or equal.)

NOTE: Prior to operating the Phase Sensitive Converter, the above equipment should be connected as shown in Figure 5.1. After making this interconnection, the validity of this test setup can only be checked by operating and testing a Phase Sensitive Converter of known calibration and test limits in order to be sure that minimum ground loops or other sources of error exist.

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Use only the first and second decades on the RB-503 Ratio Boxes used for signal input, to assure maximum accuracy.

III. Test Data

DC Offset: With shorted input, read output
Limit: 0 ± 10mv DC

MODE	DIRECT
IN-PHASE	
QUADRATURE	
TOTAL	
FUND	

AC Noise: Apply 10mv input signal, 10mv range. Observe AC output in mv peak to peak on isolated, calibrated oscilloscope in all modes.

MODE	P/PMV	ACCEPTED LIMIT
Fund		50mv
Total		50mv
In-Phase		50mv
Quad		50mv

Quadrature Rejection Gradient with Frequency: Apply 10mv signal, 90 degrees leading reference and note output in In-Phase Mode. Should read 0 ± 10mv at 400Hz and ±50mv at 380 and 420Hz.

	380~	400~	420~
In-Phase			
Limit	±50mv	±10mv	±50mv

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Range Check: Apply In-Phase, full scale inputs ± .01% 400Hz.

Range Limits: 10V ±10mv except 3V ± 10mv for 300V input
Quad Limits: 0 ± 10mv

MODE	Input / Range	10mv / 10mv	100mv / 100mv	1V / 1V	10V / 10V	100V / 100V	300V / 1000V
FUND	DIR						
TOTAL	DIR						
IN-PHASE	DIR						
QUAD	DIR						

Linearity Check: 1 Volt Range, 400Hz

NOTE: For this check, adjust full scale input to cause and output reading of exactly 10.000V DC.

AC INPUT	1V		.8V		.6V		.4V		.2V	
	DC Output	Spec	DC Output	Spec	DC Output	Spec	DC Output	Spec	DC Output	Spec
Fund/Direct		10V ± 1mv		8V ± 10mv		6V ± 10mv		4V ± 10mv		2V ± 10mv
In-Phase/Dir.										

Frequency Response:

10mv Range, 10mv Input, Total Mode

Maximum Deviation - Direct Mode

_____% 350Hz to 10KHz Limit ± 1.0% of full scale

Turnover: With unit in Direct, In-Phase Modes, 10mv Range, 400Hz apply a 10mv Input at a Phase Angle of 0° and adjust Converter to exactly 10.000V using Ratio Box, invert input and record.
Limit = 10V ± 10mv

0°	
180°	

Response Time: In-Phase Mode, 10mv Range, Switch from 300 volts input to 0 volts input.

TIME OF RECOVERY TO WITHIN ±20mv OF FINAL STEADY STATE VALUE	LIMIT
_____seconds	Less than 1.5 sec.

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CALIBRATION PROCEDURE

I. The following procedure will identity calibration adjustments which may be required in the event of an out of specification reading during the conductance of the Performance Evaluation Procedure (See Note page 5.1) (See Figure 4.4, Calibration Adjustment Locations.)

II. Calibration Adjustments

1. DC Balance - With the instrument programmed to Direct Input, 1000V Range, Quadrature Mode and zero (0) input signal (input terminals shorted) the output should read 0 ±2mv. If it does not, readjust R1328 to produce an output of as near zero (0) as possible.

2. DC Offset - No adjustment. An out of specification reading indicates a malfunction in the instrument or test set up (check grounds).

3. AC Noise - No adjustment. An out of specification reading indicates a malfunction in the instrument or test set up. (check grounds)

4. Quadrature Rejection Gradient with Frequency - Adjust R1116 for 0 ±10mv @ 400Hz.

5. Amplitude and In-Phase Rejection Gradient with Frequency - (Make all adjustments at 400Hz).

   a. For Fund Amplitude, adjust R1319 for 10V ± 10mv.

   b. For Quadrature Mode, (In-Phase Rejection) adjust C1101 for 0 ± 10mv.

6. Range Adjustments

   a. 10mv Range:
   Fund Mode, adjust R1319 for 10V ± 10mv (repeat of step 5a).

   Quad Mode, adjust C1101 for 0 ± 10mv (repeat of step 5b).

   Total Mode, adjust R1532 for 10V ± 10mv.

b. 100mv Range:
Fund Mode, adjust R1625 for 10V ±10mv.
Quad Mode, no adjustment. An out of specification reading indicates a malfunction.

c. 1V Range:
Fund Mode, adjust R1622 for 10V ±10mv.
Quad Mode, adjust C1612 for 0 ± 10mv.

d. 10V Range:
Fund Mode, adjust R1603 for 10V ±10mv.
Quad Mode, adjust C1602 for 0 ± 10mv.

e. 100V and 1000V Ranges - These ranges use attenuators adjusted on previous ranges and cannot be independently adjusted.

7. Linearity - No adjustment. An out of specification reading indicates a malfunction.

8. Frequency Response:

a. Direct Input: Select a new value for C11.

9. The following are the remainder of the tests performed. These cannot be adjusted and out of specification readings indicate a malfunction.

a. Turnover
b. Response Time

Test Fixture Rack
Ground one side
of 28V D.C. to
house ground
depending on
polarity of pro
115V 60-400~ Power
House Ground
Chassis

Figure 5.1

WARRANTY

A. North Atlantic Industries, Inc. warrants the Product(s) against defects in material and workmanship for one year from the date of original shipment. The Seller's liability is limited to the repair or replacement of the Product(s) which proves to be defective during the Warranty period.

B. North Atlantic Industries, Inc. specifically excludes from the Warranty,

1) Fuses and electron tubes.

2) Mechanical wear associated with normal operation of the Product(s). Life characteristics of mechanical assemblies such as switches, relays, and gear trains are based upon actual operating conditions, and end-of-life can occur within the Warranty period. The Seller's instruction manual or data sheet shipped with the Product(s) will normally notify the Purchaser of life related parts or assemblies.

3) Recalibration of the Product(s).

C. North Atlantic Industries, Inc. is not liable for consequential damages or for any injury or damage to persons or property resulting from the operation or application of the Product(s).

D. The Warranty is voided if there is evidence that the Product(s) has been operated beyond its design range, improperly maintained or physically mistreated.

E. In the event of malfunction in the Product(s) under Warranty, the Purchaser should notify the Seller's local Sales Representative or the Seller's Marketing Services Department giving full details of the defect and providing the model and serial number (if applicable) of the Product(s). Service data, corrective action, or shipping instructions will be forwarded promptly. There is no charge for Warranty repair of the Product(s) except for transportation charges. However, the Purchaser shall be responsible for the Product(s) shipped until received by the Seller.

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F. North Atlantic Industries, Inc. reserves the right to make changes and improvements to the Product(s) without any liability for incorporating such changes or improvements in any Product(s) previously sold, or for any notification to the Purchaser prior to shipment. In the event the Purchaser should require subsequently manufactured lots of the Product(s) to be identical to the equipment delivered in this order, the Seller will, upon written request, provide a quotation upon a change control program.

G. No other Warranty expressed or implied is offered by the Seller other than the foregoing.

CLAIMS FOR DAMAGE IN SHIPMENT

The purchaser should inspect and functionally test the Product(s) in accordance with the instruction manual as soon as it is received. If the product is damaged in any way, including concealed damage, a claim should be filed immediately with the carrier, or, if insured separately, with the purchaser's insurance company.

SHIPPING

On products to be returned under warranty, await receipt of shipping instructions, then forward the instrument prepaid to the destination indicated. The original shipping containers with their appropriate blocking and isolating material is the preferred method of packaging. Any other suitably strong container may be used providing the product is wrapped in heavy paper or a plastic bag and surrounded with at least four inches of shock absorbing material to cushion firmly, preventing movement inside the container.

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*New York Office: Columbia Commerce Corp.: 212-758-2790

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ELECTRICAL STANDARDS REPAIR SERVICE INC.
North Hollywood: 213-765-4224

FLORIDA
BCS ASSOCIATES, INC.
Orlando: 305-843-1510

WARRANTY REGISTRATION

Please complete and mail this Warranty Registration Card without delay. Placing this Registration on file with our Service Department will assure that you receive applicable service data as issued. No postage is required.
(Mailed on_____ by_____)

WARRANTY REGISTRATION

Date _____

Please register _____

Model No. _____ Serial No. _____

under the terms of the warranty stated in this Instruction Manual.

Name _____

Title _____ Dept. _____

Company _____

Address _____

City _____ State _____ ZIP _____

Calibration and maintenance responsibility has been assigned to the following person and/or department. Address applicable service data to (if same as above, please state):

Name _____

Title _____ Dept. _____

For our information please indicate:

Condition of instrument on receipt _____

Application _____

Will the instrument be: resold as part of a system? _____

maintained as company equipment? _____

SERVICE INFORMATION

This card is provided to aid you in obtaining prompt assistance with questions you may have regarding operation, calibration, maintenance or service parts for your North Atlantic instrument. State information desired and mail. No postage is required.

SERVICE INFORMATION REQUEST

Instrument _____

Model No. _____ Serial No. _____

We require the following service information: _____

_____

_____

_____

_____

Name _____ Title _____

Company _____ Dept. _____

Address _____

City _____ State _____ ZIP _____

Phone _____ Ext. _____

SERVICE INFORMATION

This card is provided to aid you in obtaining prompt assistance with questions you may have regarding operation, calibration, maintenance or service parts for your North Atlantic instrument. State information desired and mail. No postage is required.

SERVICE INFORMATION REQUEST

Instrument _____

Model No. _____ Serial No. _____

We require the following service information: _____

_____

_____

_____

_____

Name _____ Title _____

Company _____ Dept. _____

Address _____

City _____ State _____ ZIP _____

Phone _____ Ext. _____

(please send additional Service Information Request cards)

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Postage Will be Paid by Addressee

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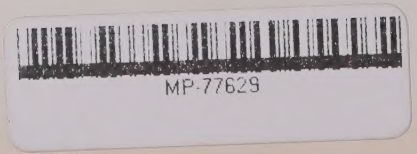
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